

COMPRESSIVE AND FLEXURAL STRENGTH IMPROVEMENT OF JUTE FIBRE REINFORCED POLYMER COMPOSITE

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ABSTRACT

Jute fibre reinforced composites, have replaced the most widely used synthetic fibre (glass) reinforced composites in many applications. In the present experimental endeavor, jute fibre-epoxy resin reinforced composites, were prepared using hand lay-up molding process. Jute fiber reinforced epoxy composites had better flexural strength, with transverse fiber distribution in the composites. Chemical characterization will remove impurities of material and increases mechanical properties of the composite. Composites based on jute fiber and epoxy resin, was fabricated by hand lay-up technique. The mechanical properties of the composites, such as compressive strength, flexural strength and flexural modulus were measured, in dependence of fiber content. The present work described, the mechanical properties and development of a new set of natural fiber based polymer composites, consisting of fiber as reinforcement with epoxy resin.

KEYWORDS: Synthetic Fibre, Stem and Ribbon, Jute Fiber & Epoxy Resin

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INTRODUCTION

The jute fiber comes from the stem and ribbon (outer skin) of the jute plant. The fibers are first extracted by retting. The retting process consists of, bundling jute stems together and immersing them in slow running water. There are two types of retting: stem and ribbon. After the retting process, stripping begins; women and children usually do this job. In the stripping process, non-fibrous matter is scraped off, and then the workers dig in and grab the fibers from within the jute stem. Jute is a rain-fed crop, with little need for fertilizer or pesticides, in contrast to cotton's heavy requirements. Production is concentrated mostly in Bangladesh, as well as India's states of Assam, Bihar and West Bengal. India is the world's largest producer of jute, but imported approximately 162,000 tonnes of raw fibre and 175,000 tonnes of jute products in 2011. India, Pakistan and China, imported significant quantities of jute fibre and products from Bangladesh, the United Kingdom, Japan, United States, France, Spain, Ivory Coast, Germany and Brazil.

Liu, Let.al., [1] poly (butylene succinate) (PBS)/ jute composites were prepared, and the effects of fibre content, diameter, surface modification and arrangement forms of the biodegradability were evaluated, by compost-soil burial test, Liu, L., et.al., [2] a bio-composite was originally fabricated and the effects of fibre surface modification on characteristics of jute fibre and mechanical properties of the bio composite were evaluated. Karmaker, A. C., et.al., [3] SYNOPSIS, Composites with polypropylene (PP) and jute fiber were prepared by

injection molding technique. Maleic anhydride-grafted polypropylene was added as coupling agent, to improve the adhesion between jute fiber and PP. Akil, H. M et.al. [4] investigated the jute fibre reinforced with unsaturated polyester composites, that are subjected to water immersion tests, in order to study the effects of water absorption in its mechanical properties. Chand, N., et.al., [5] studies have been conducted, to investigate the abrasive wear behavior of jute fibre-reinforced polypropylene composites. Rana, A. K., [6] studied the ASTM test specimens which were molded, using a Cincinnati injection molding machine. At 60%, by weight of fiber loading, the use of the compatibilizer improved the flexural strength as high as 100%, tensile strength to 120% and impact strength (unnotched) by 175%. Remarkable improvements were attained, even with 1% compatibilizer. Bledzki, A. K., et.al., [7] compared the jute and flax fibre composites, with abaca fibre composites, where the jute fibre composites provided best tensile properties, but abaca fibre polypropylene composites were shown to provide best notch charpy and falling weight impact properties. Defoirdt, N et.al.,[8] studied the mean strength and standard deviation was calculated following the normal and Weibull distribution, resulting in the questionable benefit of applying the Weibull distribution, prepared hybrid composites by hand lay-up technique, by reinforcing jute and oil palm fibres, with epoxy matrix. The tensile properties of hybrid composites, were found to increase substantially, with increasing jute fibres loading, as compared to oil palm-epoxy composite. Acha, B.A et.al.,[9] studied the dynamic mechanical response and the short term creep-recovery behavior, of composites made from bi-directional jute fabrics and polypropylene. Wambua, P., et.al., [10] processed the natural fibres (sisal, kenaf, hemp, jute and coir) reinforced polypropylene composites, by compression moulding, using a film stacking method. The mechanical properties of the different natural fibre composites, were tested and compared.

METHODOLOGY

Preparation of Jute Fibre Reinforced Polymer Composite



Figure 1: Preparation of Jute Fibre Reinforced Polymer Composite

Prepared a cope drag box of 200×200×20 mm, length × breadth × height (wood or aluminium), and a plastic film sheet was taken and covered it from the bottom of the box firmly. After completely blocking one side of the box, it was placed gently. Now, took the mould relief spray and sprayed on the film sheet, for easy relief after bonding and now the resin and hardener was taken, we used depoxy resin here, from araldite [Aw 106, resin] [HV 9531N hardener], it was mixed with the resin and hardener, in a proportion of 10:1 ratio, of weight to volume. Stirred it well, by adding 5gms of carbon powder for 15 minutes and poured the resin uniformly on the plastic layer, on the drag box. After finishing from top to bottom, now resin was poured gently on the strands. Continued the process for 4 layers by using roller, the surface of the composite layer was spread uniformly. The air bubbles were removed and further rolled. Finally the mould was left in a

dry place for air drying, for 24-48 hrs. After that, the jute fibre reinforced composite was obtained. The process of the work is shown in figure 1.

RESULTS AND DISCUSSIONS

Compression Test

The compression test on the specimen of the dimensions 95mm × 20mm × 12mm, was done by using Hydraulic Operated Computerized Universal Testing Machine (UTM), of measuring capacity of (±100kN) with 150mm of usable stroke. It was designed for both static and dynamic testing, on a variety of a materials and components.

Compression Test Specimen Specification

Length	: 95mm
Breath	: 20mm
Height	: 12mm

Table 1: Compression Test on Jute Composite

Laboratory Name	Mechanical Lab
Company	GITAM University
Rate 1	3.00000 mm/sec

Table 2: Raw Specimen Data of Compressive Test of Jute Composite

S. No	Time (sec)	Load (N)	Compressive Load (N)	Compressive Strain (mm/mm)
	1	-3529.66	3529.661	0.01049
	2	-5967.8	5967.803	0.02107
	3	-6089.98	6089.978	0.02159
	4	-6192.24	6192.239	0.02212
	5	-6298.91	6298.911	0.02264
	6	-6361.29	6361.291	0.02315
	7	-6405.3	6405.298	0.02368
	8	-6437.27	6437.272	0.02423
	9	-6447.73	6447.732	0.02476
	10	-6342.61	6342.611	0.02526

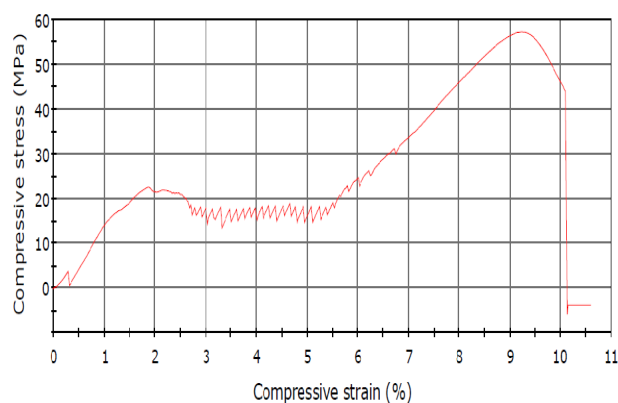


Figure 2: Compressive Stress (Mpa) Vs Compressive Strain (%)

From the above figure 2, we get the values of compressive stress and compressive strain as, 57.21 MPa and 0.09212(%), respectively

Table 3: Compressive Test on the Specimen

S. No	Specimen Label (Jute)	Maximum (Kn)	Compressive Strength (Mpa)	Compressive Strain at Maximum Compressive Load (Mm/Mm)	Load at Maximum Compressive Load (Kn)	Modulus (Mpa)	Axial Gauge Length(Strain Source) (Mm)
1.	Mean	13.73	57.21	0.09212	-13.73035	1983.69798	-95.00109
2.	Standard Deviation	0.000	0.000	0.000	0.000	0.000	0.000
3.	Minimum	13.73	57.21	0.09212	-13.73035	1983.69798	-95.00109
4.	Maximum	13.73	57.21	0.09212	-13.73035	1983.69798	-95.00109
5.	Range	0.000	0.000	0.000	0.000	0.000	0.000

The values of stress, strain and young's modulus, for test are as follows.

The initial load of 0.31199N to the maximum load of -5299.52 N was given, for the experiment. At the maximum load of -5299.52 N, the specimen compressed completely. The compressive load and strain values for initial conditions were, -0.31199N and 0 respectively, and for final conditions, it were 5299.52 N and 0.02998, respectively. The compression started after 0.05 sec, at that time the compressive load and compressive strain for initial conditions were 103.6795 N and 0.00043, respectively and for final conditions the values were 5299.522 N and 0.02998, respectively.

FLEXURAL (BENDING) TEST

The Flexural test on the specimen of the dimensions 95mm × 35mm × 12mm was done by using, Hydraulic Operated Computerized Universal Testing Machine (UTM) with measuring capacity of, (±100kN) with 150mm of usable stroke. It was designed for both static and dynamic testing, on a variety of a materials and components.

Flexural test specimen specification:

Length : 95mm
 Breath : 35mm
 Height : 12mm

Table 4: Flexural Test on Jute Composite

General: Number of specimens	25
Number Inputs: Humidity (%)	50.00
Number Inputs: Temperature (C)	18.00
Text Inputs: Company	GITAM UNIVERSITY
Text Inputs: Laboratory Name	MECHANICAL LAB

Table 5: Raw Specimen Data of Flexural Test of Jute Composite

S.No.	Time (Sec)	Extension (Mm)	Load (N)
1.	1	-0.08113	-80.103
2.	2	-0.16302	-164.99

3.	3	-0.24881	-271.55
4.	4	-0.3307	-403.603
5.	5	-0.41403	-540.004
6.	6	-0.49704	-680.846
7.	7	-0.50134	-689.214
8.	8	-0.50515	-694.151
9.	9	-0.51035	-700.741
10.	10	-0.5134	-707.204

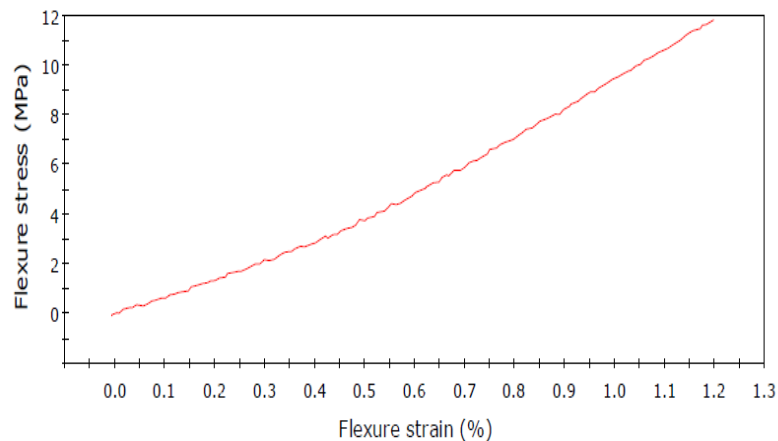


Figure 3: Flexural Stress Vs Flexural Strain

From the above figure 3, the values of flexural stress and flexural strain are 11.8 MPa and 1.973(%), respectively.

Table 6: Flexural Test on the Specimen

S.No.	Specimen label (jute)	Max. Flexure load (kN)	Max. Stress (MPa)	Load at Max. Flexure load (kN)	Flexure load at Max. Flexure stress (kN)	Flexure strain at Max. Flexure load (%)	Flex Modulus (MPa)
1	Mean	0.77547	11.8	-0.77547	0.77547	1.19733	1208.32
2	Standard Deviation	0.000	0.000	0.000	0.000	0.000	0.000
3	Minimum	0.77547	11.8	-0.77547	0.77547	1.19733	1208.32
4	Maximum	0.77547	11.8	-0.77547	0.77547	1.19733	1208.32

In flexural test the specimen undergoes both tension and compression. The lower surface of the specimen undergoes tension and the upper surface undergoes compression. The initial tensile extension of the specimen was 0.00275mm is occurred, at the load of 4.97811 N. After 0.05 sec the specimen undergoes compression. The extension of specimen was -0.00225mm, at initial compressive load of 3.29139N. The extension of specimen was -0.55261mm, at final compressive load of 775.469N, for the time of, 6.65 sec.

The values of stress, strain and young's modulus for tensile and compression, are as follows.

Compression Test

Compressive Stress: 57.21MPa

Strain: 0.09212%

Young's Modulus: 1983.69798MPa

Flexural (Bending) Test:

Max. Stress: 11.8 MPa

Flexure strain at Maximum Flexure load: 1.19733%

Flex Modulus: 1208.32 MPa

CONCLUSIONS

- The effect of chemical treatment of jute epoxy composite, in altering the mechanical properties such as compressive and flexural has been studied.
- The process of this experiment, increases mechanical properties of the material in compressive and flexural test.
- Results of this experiment shows, one new method of neutralisation of material, before preparation of the composite.
- Natural fibres are replacing synthetic fibres, as reinforcement in various matrices. The composites prepared effectively, are used as substitute for wood and also in various other technical fields like seat back and dash boards, in automobile sector and flooring and ceiling, in transportation sector.

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